Mark schemes

1 (a) $2Cl^- \longrightarrow Cl_2 + 2e^{(-)}$

Allow $2Cl^- - 2e^{(-)} \longrightarrow Cl_2$

Allow correct equation forming ClO^- *but not* Cl^+

1

(b) $2ClO^- + 4H^+ + 2e^- \longrightarrow Cl_2 + 2H_2O$

Allow HClO in correctly balanced equation

1

(c) $ClO^- + Cl^- + 2H^+ \longrightarrow Cl_2 + H_2O$

allow $HClO + HCl + \longrightarrow Cl_2 + H_2O$

1

(d) Goes brown (or shades of brown)

Allow black ppt/solid but NOT black solution or purple

1

Due to iodine or I_3^-

Correct ½ equation scores M2 and M3

1

Because I^- oxidised

1

[6]

2 (a) Increasing atomic radius / shielding / number of shells / size (down group) or reverse argument

NOT *'molecules'*

1

Decreasing attraction of <u>nucleus/protons</u> for shared (electron) pair / bond electrons

NOT *if attraction for single electron implied*

1

(b) (i) Electron acceptor / species that accepts electrons / species that gains electrons

NOT *electron pair*

NOT *just 'gain of electrons'*

1

(ii) Chlorine 0 to –1 / oxidation state/number of chlorine decreases
AND
Bromine –1 to 0 / oxidation state/number of bromine increases

Penalise if oxidised for chlorine and/or reduced for bromine

Credit oxidation states if labelled on equation

1

(c) (i) $H_2SO_4 + 8H^+ + 8e^{(-)} \longrightarrow H_2S + 4H_2O$

ALLOW *$SO_4^{2-} + 10H^+ + 8e^{(-)} \longrightarrow H_2S + 4H_2O$*

ALLOW *fractions/multiples*

IGNORE *state symbols*

1

(ii) $2I^- \longrightarrow I_2 + 2e^{(-)}$

ALLOW *fractions/multiples*

IGNORE *state symbols*

ALLOW *$2I^- - 2e^{(-)} \longrightarrow I_2$*

1

(iii) $H_2SO_4 + 8H^+ + 8I^- \longrightarrow H_2S + 4H_2O + 4I_2$

ALLOW

$H_2SO_4 + 8HI \longrightarrow H_2S + 4H_2O + 4I_2$

$SO_4^{2-} + 2H^+ + 8HI \longrightarrow H_2S + 4H_2O + 4I_2$

$SO_4^{2-} + 10H^+ + 8I^- \longrightarrow H_2S + 4H_2O + 4I_2$

$9H_2SO_4 + 8I^- \longrightarrow H_2S + 4H_2O + 4I_2 + 8HSO_4^-$

$9H_2SO_4 + 8NaI \longrightarrow H_2S + 4H_2O + 4I_2 + 8NaHSO_4$

$H_2SO_4 + 8H^+ + 8NaI \longrightarrow H_2S + 4H_2O + 4I_2 + 8Na^+$

$5H_2SO_4 + 8I^- \longrightarrow H_2S + 4H_2O + 4I_2 + 4SO_4^{2-}$

$5H_2SO_4 + 8NaI \longrightarrow H_2S + 4H_2O + 4I_2 + 4Na_2SO_4$

1

(iv) 'Oxidising agent' box ticked

1

(v) $H_2SO_4 + 2NaF \longrightarrow Na_2SO_4 + 2HF$

OR

$H_2SO_4 + NaF \longrightarrow NaHSO_4 + HF$

1

(vi) Fluoride less powerful reducing agent (than iodide)

OR

Fluoride less easily oxidised than iodide

Or reverse argument in either case

NOT *general group VII trend statement*

NOT *fluorine/F or iodine/I*

Must be comparative

1

(d) (i) $Cl_2 + H_2O \rightleftharpoons 2H^+ + Cl^- + ClO^-/HCl + HOCl$

ALLOW *$\longrightarrow$ for $\rightleftharpoons$*

1

(ii) Equilibrium shifts/moves left

1

(Producing) chlorine (which) is toxic/poisonous

Mark independently

1

[13]

3 (a) $2NaBr + 2H_2SO_4 \longrightarrow Na_2SO_4 + Br_2 + SO_2 + 2H_2O$

Allow ionic equation

$2Br^- + 2H_2SO_4 \longrightarrow Br_2 + SO_4^{2-} + SO_2 + 2H_2O$

1

Br^- ions are bigger than Cl^- ions

1

Therefore Br^- ions more easily oxidised / lose an electron more easily (than Cl^- ions)

1

(b) This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question.

Level 3

All stages are covered and the explanation of each stage is generally correct and virtually complete. Stages 1 and 2 are supported by correct equations.

Answer communicates the whole process coherently and shows a logical progression from stage 1 to stage 2 and then stage 3. The steps in stage 3 are in a logical order.

5–6 marks

Level 2

All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete.

Answer is mainly coherent and shows a progression through the stages. Some steps in each stage may be out of order and incomplete.

3–4 marks

Level 1

Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies, OR only one stage is covered but the explanation is generally correct and virtually complete.

Answer includes some isolated statements, but these are not presented in a logical order or show confused reasoning.

1–2 marks

Level 0

Insufficient correct chemistry to warrant a mark.

0 marks

Indicative chemistry content

***Stage 1**: formation of precipitates*

- *Add silver nitrate*
- *to form precipitates of AgCl and AgBr*
- $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
- $AgNO_3 + NaBr \rightarrow AgBr + NaNO_3$

***Stage 2**: selective dissolving of AgCl*

- *Add excess of dilute ammonia to the mixture of precipitates*
- *the silver chloride precipitate dissolves*
- $AgCl + 2NH_3 \rightarrow Ag(NH_3)_2^+ + Cl^-$

***Stage 3**: separation and purification of AgBr*

- *Filter off the remaining silver bromide precipitate*
- *Wash to remove soluble compounds*
- *Dry to remove water*

6

(c) $Cl_2 + 2HO^- \longrightarrow OCl^- + Cl^- + H_2O$

1

OCl^- is +1

Cl^- is –1

Both required for the mark

1

[11]

4 A

[1]

5 D

[1]

6

Ideal gas equation: pV = nRT **(1)**

Calculation: n = pV/RT = $\frac{103000 \times 127 \times 10^{-6}}{(8.31 \times 415)}$ **(1)**

mark for volume conversion fully correct

= 3.79×10^{-3} (mol) **(1)**

range 3.79×10^{-3} to 3.8×10^{-3}

M_r = m/n = .304/3.79×10^{-3} = 80.1 **(1)**

range 80 – 80.3
min 2 s.f. conseq
If 'V' wrong lose M2; 'p' wrong lose M3; 'inverted' lose M3 and M4

[5]

7

D

[1]

8

Hydroxide: *solubility increases*

1

Sulphate: *solubility decreases* *[BOTH inc/dec allow 1/2]*

[Allow correct solubilities of top (Mg) and bottom (Ba) cpds]

1

Add: $BaCl_2(aq)$ / $Ba(NO_3)_2(aq)$ / $Ba(OH)_2(aq)$

[Not solid added]

[Not Ba^{2+} / Ba / Ba + HCl / $Pb(NO_3)_2(aq)$]

[If $BaSO_4$ / H_2SO_4 used, M3 to M6 = CE = 0]

[Allow any sensible nitrate test as an alternative to the sulphate test]

1

[Note: If M3 not awarded but test would work, allow correct observations and equations]

Na_2SO_4 *white precipitate / solid / suspension*

[not cloudy/milky]

1

$NaNO_3$ *no change*

1

$BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

Accept ionic equation

1

[6]

9

(a) Ability (or power) of an atom to attract electron density (or electrons or -ve charge) **(1)**
in a covalent bond **(1)**

or shared pair
If remove an electron lose first mark

2

(b) *Trend:* increases **(1)**
Explanation: nuclear charge (number of protons) increases **(1)**
electrons in same shell **(1)**

OR similar shielding
OR atoms similar size or smaller
OR 1 mol of e^-

3

(c) Heat / enthalpy / energy for removal of one electron **(1)**
from a gaseous atom **(1)**
can score in an equation

must have first mark to score the second

2

(d) (i) 2 **(1)**

(ii) Two elements (or Na / Mg) before the drop (in energy) to Al **(1)**

(iii) ionisation energy of Al < that for Mg **(1)**

(iv) fall in energy from P to S **(1)**

or discontinuity in trend

From Al to P there are 3 additional electrons **(1)**

or three elements

For second mark idea of block of 3 elements

5

[12]

10 C

[1]

11 (a) $Mg(^{2+})$ or Magnesium

Na^+ CE=0

1

Because Mg^{2+} has more protons
AND
With the same shielding/screening/electron arrangement/number of electrons (or isoelectronic)

Allow larger/stronger nuclear charge

Ignore atomic radius

1

(b) $Na(g) \rightarrow Na^+(g) + e^-$

1 for correct species and gas phase

Allow e without charge

Allow $Na(g) - e^- \rightarrow Na^+(g)$

$Na(g) + e^- \rightarrow Na^+(g) + 2e^-$

1

(c) Mg between 600-800

1

S between 800-1040

If S not lower than P on graph then M1 only

If no plots on graph must state S below P to access M3 & M4

1

e^- paired in (3)p orbital in S (owtte)

Allow (3)p subshell/sublevel provided pair mentioned

1

Paired e^- repel (so less energy needed to remove)

1

[7]

12 (a) **Q** is calcium or magnesium

1

bromide

1

R is aluminium

1

chloride

1

S is iron(III)

1

sulfate

1

Mark this question independently

(b) $Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4$

1

$[Fe(H_2O)_6]^{3+} + 3OH^- \longrightarrow Fe(H_2O)_3(OH)_3 + 3H_2O$

1

$2[Fe(H_2O)_6]^{3+} + 3CO_3^{2-} \longrightarrow 2Fe(H_2O)_3(OH)_3 + 3H_2O + 3CO_2$

1

$[Fe(H_2O)_6]^{3+} + 4Cl^- \longrightarrow [FeCl_4]^- + 6H_2O$

1

[10]